28.3.0 MICROCONTROLLER TECHNOLOGY

28.3.01 Introduction

This module unit is aimed at providing the trainee with theoretical and practical understanding of automating processes and use of digital computers in control systems. Trainees taking this module unit require to have covered engineering control systems.
This module unit is competency based with careful integration of the theory and practice.

28.3.02 General Objectives

At the end of the module unit, the trainee should be able to:

a) Understand the operating principles of process control systems
b) Apply the operating principles of sequential control systems in industrial engineering systems.
c) Understand the operating principles of digital control systems
d) Program Robots

28.3.03 Module Unit Summary and Time Allocation

Microcontroller Technology

Code	Sub-module unit	Content	Time Hrs
28.3.1	Introduction to Microcontroller Technology	• Elements of Microcontroller Architecture • Microcontroller series • Family members of Microcontroller series	4
28.3.2	Process Control Systems	• Need for process control • Process control terms • Block diagram of process control • Control modes • Implementation of controllers • Functions of Actuators • Types of actuators	10
28.3.3	Sequential Control Systems	• Description of sequential control systems • Time delay units • Application of Decoders/ Encoders in sequential control • Practical interlock systems • Programmable logic controllers (PLC's)	10

		• Application of flow chart and ladder diagrams programming methods • Applications of PLCs in functional and practical systems	
28.3.4	Digital Control Systems	• Basic digital methods • Computer data logging • Human machine interface (HMI) • Applications of digital computer	6
28.3.5	Robots fundamentals	• Definition of a robot • Types of Robots • Elements of Robotic systems • Need for Robots • Robotic classification • Functions of control systems in Robots • Robots's Performance Capabilities Specifications • Key Features of Robots • Programming methods	6
28.3.6	Robots programming	• Programming methods • Robot programming functions • Robot programming environment • Programming activities • Basic types of robot programming languages • On-line and off-line programming languages	8
Total time			**44**

28.3.1 INTRODUCTION TO MICROCONTROLLER TECHNOLOGY

Theory

28.3.1T0 *Specific Objectives*
By the end of the sub - module unit, the trainee should able to:
a) explain the elements of a microcontroller architecture
b) describe various microcontroller series
c) explain the family members of a microcontroller series

Content

28.3.1T1 Elements of a microcontroller architecture
i) CPU
ii) RAM
iii) ROM/EPROM
iv) Input / Output ports
v) Timers / Counters

28.3.1T2 Microcontroller series
i) Intel 8048
ii) Intel 8051
iii) Intel 8096
iv) NEC 7800
v) Intel 8044

28.3.1T3 8051 Microcontroller family members
i) 8032 AH
ii) 8751 AH
iii) 80C32
iv) 8052
v) 8032

28.3.2 PROCESS CONTROL SYSTEMS

Theory

28.3.2T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain the need for process control
b) explain process control terms
c) explain block diagram of process control
d) explain controller modes
e) describe implementation of controllers
f) explain functions of actuators
g) distinguish between different types of actuators

Content

28.3.2T1 Need for process control
i) Safety
ii) Quality
iii) Environment
iv) Economics

28.3.2T2 Process control terms
i) Lag time
ii) Dead time
iii) Dead band
iv) Set point
v) Error signal
vi) Transient
vii) Measured variable
viii) Controlled variable
ix) Variable range
x) Control parameter range

xi) Offset

28.3.2T3 Block diagram of process control

28.3.2T4 Control modes
On/off
i) Proportional
ii) Integral
iii) Differential
iv) Proportional +integral (PI)
v) Proportional +differential (PD)
vi) Proportional +integral + differential (PID)
vii) Tuning of PID- Ziegler-Nichols method

28.3.2T5 Implementation of controllers
i) Pneumatic On/off controllers
ii) Electrical On/off controllers
iii) Pneumatic PID controllers
iv) Electronic PID controllers
v) Computer or PLC processor

28.3.2T6 Functions of Actuators

28.3.2T7 Types of actuators
i) Solenoid
ii) Digital stepper motor drives
iii) Stepper motor drives
iv) IC L298
v) IC SAA1027
vi) Pneumatic
vii) Hydraulic

Practice

28.3.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) implement the control modes using OP-amps
b) tune a three term controller
c) dismantle and assemble a typical pneumatic control valve

Content

28.3.2P1 Implementation of control modes
i) Two position
ii) P-I
iii) P-D
iv) P-I-D
v) Tuning a three term controller
vi) Ziegler Nichols method
vii) Controller settings

28.3.2P2 Tuning a three term controller

28.3.2P3 Dismantling and assembling a Pneumatic control valve

28.3.2C Competence
The trainee should have the ability to:
i) implement a control mode
ii) tune a three term controller

Suggested teaching/Learning Activities
- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries

Suggested Learning Resources
- Selected controllers and actuators

- Reference books
- Field visits
- Electrical measuring instruments
- Electronic tool kit
- Dc Power supply
- Signal generators
- Ac power supply
- Electronic devices
- Electronic components
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Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

28.3.3 SEQUENTIAL CONTROL SYSTEMS

Theory

28.3.3T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to :

a) describe sequential control
b) explain time delay units
c) apply decoders/ encoders in sequential control
d) explain practical interlock system control
e) describe the Programmable Logic Controllers
f) explain the various types of Programmable Logic Controllers
g) apply Flow chart and ladder diagram programming methods
h) apply PLC's to practical systems

Content

28.3.3T1 Sequence control
28.3.3T2 Time delay units
i) Control relays
ii) Digital
iii) Analogue
28.3.3T3 Application of decoders/ encoders
-Identification
28.3.3T4 Practical interlock systems
i) Solenoid
ii) Limit switches
iii) Control relays
iv) Digital
v) Analogue
28.3.3T5 Internal architecture of Programmable Logic Controllers (PLC)
i) Input/ Output channels
ii) Memories
iii) Types of Programmable Logic Controllers
iv) Moeller
v) Mitsubishi
vi) Eaton
vii) Siemens
28.3.3T6 Flow chart and ladder diagram programming methods
28.3.3T7 Application of PLCs

Practice

28.3.3P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:

a) apply Flow chart and ladder diagram programming methods

b) write programs for PLC's
c) apply PLC's to practical systems

Content

28.3.3P1 Application of flow charts and ladder diagram
i) Flow chart
ii) Ladder diagram
iii) Developing programs

28.3.3P2 Writing programs for PLC's
i) Programmes techniques for multiplexing
ii) Limited channel
iii) Running several programmes simultaneously

28.3.3P3 Applying PLC's
i) Mimic diagrams
ii) Alarm condition
iii) Latch system

28.3.3C Competence

The trainee should have the ability to: program a PLC

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries

Suggested Learning Resources

- Selected PLC's
- Reference books
- Field visits

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

28.3.4 DIGITAL CONTROL SYSTEMS

Theory

28.3.4T *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:
a) explain the application of digital methods to solve problems
b) use computer application to provide data logging
c) describe human machine interface(HMI)
d) explain the application of digital computers in process control

Content

28.3.4T1 Basic digital methods
i) Single and multiple alarms
ii) Digital control using logic circuits for system
iii) Interactive multivariable control

28.3.4T2 Computer data logging
i) Data logger
ii) Multiplexer
iii) ADC, address lines, console
iv) Computer supervisory

28.3.4T3 Human machine interface (HMI)

28.3.4T4 Applications of Digital computer
i) Temperature

ii) Remote position control
iii) Stepper motor

Practice

28.3.4P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) Solve industrial control problems using digital methods
b) Use computers in industrial process control

Content
28.3.4P1 solution of industrial controls problems
28.3.4P2 computer applications in industrial process controls

28.3.4C Competence
The trainee should have the ability to: install a and maintain a SCADA system

Suggested teaching/Learning Activities
- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries

Suggested Learning Resources
- SCADA computer
- Reference books
- Field visits

Suggested Evaluation Methods
- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

28.3.5 FUNDAMENTALS OF ROBOTS

Theory

28.3.5T0 *Specific Objectives*
By the end of the sub-module unit , the trainee should be able to:
a) define a robot
b) explain the types of robots
c) explain the elements of robotic system
d) explain the need for using robots
e) classify robots
f) describe the functions of control system in robots
g) describe the performance capability of a robot
h) outline the features of a robot
i) use various robot programming methods

Content
28.3.5T1 Definition of a robot
28.3.5T2 Types of robots
i) Manual
ii) Semi Automatic
iii) Automatic
28.3.5T3 Elements of a Robotic System
i) Components of robot manipulator
ii) Control system
iii) Computer system
28.3.5T3 Needs for using robots
i) Degree of freedom

ii) Roll
iii) Pitch
iv) Drive systems
v) Pneumatic actuator systems
vi) Hydraulic actuator systems
vii) Electric actuator systems

28.3.5T5 Functions
i) Generating the path of motion for the manipulator
ii) Feedback devices
iii) Co-ordinate transformation
iv) Safety controls
v) Interfaces
vi) Robot control through non-servo operation
vii) Servo-controlled robots

28.3.5T6 Performance
i) Capabilities Specifications
ii) Axes of motion
iii) Work envelope
iv) Speed
v) Accelerometer

28.3.5T7 Key Features of Robots
i) Quality
ii) Serviceability
iii) Safety
iv) Modularity
v) Dexterity

28.3.5T8 Programming methods

Practice

28.3.5P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:
a) identify elements of a robotic system
b) assemble the robotic elements

Content

28.3.5P1 Elements of a robotic system
i) Drives
ii) Sensors
iii) Microcontroller chips
iv) Actuators
v) Motors
vi) Arm

28.3.5P2 Assembling a Robotic element

28.3.5C Competence

The trainee should have the ability to: assemble robots

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries
- Timed practical tests

Suggested Learning Resources

- Reference books
- Field visits Drives
- Sensors
- Microcontroller chips
- Actuators
- Motors
- Arm
- Electronic tool kit
- Dc Power supply

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

28.3.6 **PROGRAMMING OF ROBOTS**

Theory

28.3.6T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain programming methods
b) describe robot programming functions
c) describe robot programming environment
d) describe robot programming activities
e) describe basic types robot programming languages
f) describe on-line and off-line programming languages

Content

28.3.6P1 Programming methods
i) Guiding
ii) Teach pedant
iii) Off-line programming

28.3.6P2 Robot programming functions
i) World modeling
ii) Path generation
iii) Sensing
iv) Programming support

28.3.6P3 Robot programming environment

28.3.6P4 Programming activities

28.3.6P5 Basic types of robot programming languages
i) Basic
ii) C++
iii) AVR studio

28.3.6P6 On-line and off-line programming languages

Practice

28.3.6P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to develop simple programs to manipulate robots

Content

28.3.6P1 Programming methods
i) Guiding
ii) Teach pedant
iii)Off-line programming

28.3.6C Competence
The trainee should have the ability to: develop simple robot program

Suggested teaching/Learning Activities
- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries
- Timed practical tests

Suggested Learning Resources
- Reference books
- Field visits

Suggested Evaluation Methods
- Oral tests
- Timed written tests
- Assignments